

ART. XVII.—*The Older Tertiaries of Maude, with an
Indication of the Sequence of the Eocene Rocks of
Victoria.*

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[Read 13th September, 1894].

The sections of the tertiary rocks displayed in the valley of the Moorabool River, near Maude and to the northward, were early recognised as throwing considerable light on the correlation of beds which are separately better developed elsewhere. In 1866 Sir Alfred R. C. Selwyn reported to Parliament* on the age of the Victorian gold drifts, and the report was, in the following year, reprinted by him with reduced copies of the sections therein contained in the Exhibition Essays.†

On the evidence there detailed, the older volcanic rocks, the plant beds underlying them and certain non-auriferous gravels occurring in the neighbourhood of Maude, and elsewhere in the colony, were referred to the miocene of the survey, that is to our eocene. Mr. C. S. Wilkinson, assisted by Mr. R. A. F. Murray, made a minute geological survey of a part of the district, and the quarter-sheet (19 S.W.) which includes the most important part of the area, was published in 1865. Unfortunately the sheet of sections and explanatory notes, which should have accompanied the map, has never appeared. The results of our observations on the eocene bed at Curlewis‡, rendered it advisable that an early visit should be paid to the Maude district, and a recent vacation has afforded us the desired opportunity.

* Votes and Proceedings of the Legislative Assembly of Victoria, 2nd Session, 1866, vol. i.

† Exhibition Essays, 1866-67, pp. 21-26.

‡ Proc. Roy. Soc. Vic., 1893, p. 18.

The eocene rocks occupy an area of slightly elevated ground flanking the ordovician rocks which extend south from Steiglitz. To the east, south, and west, the country is covered by an almost unbroken sheet of what is generally called the "Newer Volcanic Rock." The surface of the exposed eocene rises slightly above the level of the basaltic plain, and the geological boundary is marked on the west by the valley of the Moorabool River, and on the east by that of Sutherland's Creek, the two streams meeting a little to the south of the area. The eocene beds underlie the basaltic plains and are exposed wherever the streams have cut through the overlying rock, which extends from Port Phillip to beyond Hamilton in the west. The valleys of the two streams above alluded to are very striking features in the district. Aneroid measurements showed their depth to be about 250 feet in each case, and the Moorabool Valley averages about a mile in width, while that of Sutherland's Creek is slightly narrower. It is in the sections displayed along these steep sided valleys that the geology of the district can best be studied.

The bed rock of the immediate neighbourhood is ordovician, but granite outcrops frequently between the Anakie Hills and the Dog Rocks, near Geelong, both of which are composed of this rock. Aided by the quarter-sheet, we examined all the marine eocene outcrops we could find, and a description of the more instructive sections will make the structure of the district clearer.

On the Moorabool, a section line is indicated on the map crossing the valley, and passing through an outcrop of limestone underlying the older volcanic rock. This line we examined carefully. The surface soil on the east of the valley is very sandy, so that there is at first a very gradual descent towards the stream. The section is approximately as follows:—

EOCENE—

Sandstone passing down into limestone	? 40 feet.
Limestone	... .. 10 „
Older volcanic	... .. 120 „
Sandy limestone and conglomerate	... 30 „

ORDOVICIAN—

Slates and sandstones	... .. 40 „
<hr/>	
240 feet.	

The sandstone capping the hill covers the whole of the area between the two streams, excepting in one or two places where an outlier of newer volcanic rock overlies it, or where minor valleys have cut through it. It gradually passes down into limestone which is in places largely composed of polyzoa and echini spines. The base of the limestone rests on the surface of the basalt, which, though approximately level when taken as a whole, is carved into steep and irregular depressions. The lower part of the limestone is full of well rounded basalt fragments, from mere pebbles up to blocks of great size. Close to the junction, and extending up from it for a variable distance in the different sections, the limestone is altered to a hard pink crystalline rock, which is described by Professor Sir F. McCoy as in some places "closely resembling lithographic stone."*

This rock is full of fossils, but for the most part they exist as casts only. They consist of trochiform shells, haliotis, cerithium, and such forms as to-day live on the rocky, bouldery parts of our coasts. That the Maude fossils are littoral forms has been pointed out by Sir Fredk. McCoy.† The talus blocks of this hard limestone are thickly strewn over the slopes below the outcrop, and dozens of specimens, picked up at random and broken with the hammer, displayed, in nearly every instance, rounded fragments of basalt embedded in the mass. In no single section did we find any evidence of the intercalation of a thin sheet of basalt. We inspected every outcrop we could find, and they were many, and followed the valley some distance south of the boundary of the quarter-sheet into unmapped country, but could find no sign of the basalt which is represented on the map as overlying the limestone, and as being in its turn overlain by other "miocene" (eocene) beds. The numerous small quarries for limestone showed over and over again, rounded pebbles and blocks of basalt scattered through the rock. As we go up from the basalt we find the limestone becoming less and less altered, till it assumes the character of the ordinary polyzoal rock, that is a rock of which the well-known Waurn Ponds building-stone may be taken as the lithological type. In this comparatively unaltered rock basalt fragments occur, but are not as numerous

* *Prod. Pal. Vic.*, *Dev.* III., p. 21.

† *Id.*, p. 25.

as in the lower portion, and are often associated with small quartz pebbles. In a section displayed on the roadside between the State School and the old mill, at The Clyde, we measured one embedded basalt block exposed, and found it ten feet long and four feet thick. Another boulder was five feet by three feet six inches; and these great masses were associated with numerous fragments of all sizes, down to small pebbles; and all were well rounded. Packed in between the boulders was a deposit of comminuted polyzoa, broken and worn spines of echini, fragments of brachiopod shells and of pectens, but perfect specimens of any kind were rare.

It may be that the officers of the survey felt the necessity of accounting for the alteration of the rock to a crystalline limestone by igneous action, and were led to attribute it to an intercalated flow, taking the large included blocks as portions of such a sheet. The subsequently opened sections, however, dispose entirely of such an interpretation. On the opposite side of the river from this Clyde section, a large quarry is a conspicuous object on the hillside. This shows a clean face of nearly thirty feet, and is about fifty yards in length. The limestone, which forms the greater part of the quarry floor, rests on a very uneven basaltic surface, and extends about ten feet up the face. It is distinctly less altered as we go up from the volcanic rock, and is capped by arenaceous and calcareous beds, which reach apparently to the top of the hill. The cause of the change in character has, then, evidently acted from below, and is not due to a more recent flow of basalt. What this cause may have been is not clear to us, but we have recorded a similar alteration in the polyzoal rock overlying the ash beds of Curlewis.* Mr. D. Avery, M.Sc., has kindly examined the rock for us, and says there is only a very small amount of magnesia present, so that the changed character has not been brought about by dolomitisation.

Wherever the limestone is unaltered it is seen to be, both lithologically and palaeontologically, the equivalent of that of Waurin Ponds.

* Proc. Roy. Soc. Vic., 1893, p. 3.

COMPARATIVE TABLE BETWEEN UPPER MAUDE BEDS, AND
WAURN PONDS.

Name of Specimen.					Upper Maude Beds.	Waurn Ponds.
ZOANTHARIA.						
Placotrochus elongatus, Duncan	-	-	-	-	-	X
Notocyathus australis, Duncan	-	-	-	-	X	-
Balanophyllia australiense, Duncan	-	-	-	-	X	-
Graphularia senescens, Tate	-	-	-	-	-	X
Isis, 2 spp.	-	-	-	-	-	X
ECHINODERMATA.						
Echinobrissus vincentianus, Tate	-	-	-	-	X	-
Echinobrissus australiæ, Duncan	-	-	-	-	-	X
Echinobrissus n. sp. ?	-	-	-	-	-	X
Paradoxechinus novus, Laube	-	-	-	-	X	-
Echinolampas posteroecrassus, Gregory	-	-	-	-	+X	X
Psammechinus Woodsii, Laube	-	-	-	-	+X	X
Scutellina patella, Tate	-	-	-	-	+X	X
Schizaster abductus, Tate	-	-	-	-	+X	-
? Toxobrissus sp.	-	-	-	-	X	X
Pericosmus Nelsoni, McCoy	-	-	-	-	-	X
Eupatagus murrayanus	-	-	-	-	-	X
Holaster australis, Duncan	-	-	-	-	-	X
Cyclaster archeri, T. Woods	-	-	-	-	-	X
Cidaroid plates and spines	-	-	-	-	X	X
CRUSTACEA.						
? Balanus sp.	-	-	-	-	X	X
Crab remains	-	-	-	-	X	-
POLYZOA					Abundant	Abundant
PALLIOBRANCHIATA.						
Waldheimia furcata, Tate	-	-	-	-	X	X
Waldheimia grandis, T. Woods	-	-	-	-	X	X
Waldheimia insolita, T. Woods	-	-	-	-	-	X
Waldheimia tateana, T. Woods	-	-	-	-	X	-
Waldheimia corioensis, McCoy	-	-	-	-	-	X
Waldheimia garibaldiana, Davidson	-	-	-	-	-	X
Terebratula vitreoides, T. Woods	-	-	-	-	-	X
Rhynchonella squamosa, Hutton	-	-	-	-	X	X
Terebratulina scoulari, Tate	-	-	-	-	X	X
Magasella compta, G. B. Sowerby	-	-	-	-	X	X
Crania quadrangularis, Tate	-	-	-	-	X	X
Terebratella n.sp. aff. pentagonalis	-	-	-	-	X	-
Terebratella (?) sp. nov.	-	-	-	-	X	-
LAMELLIBRANCHIATA.						
Ostrea sp.	-	-	-	-	X	X
Placumanomia ione, Gray	-	-	-	-	-	X
Dimya dissimilis, Tate	-	-	-	-	X	X
Pecten foulcheri, T. Woods	-	-	-	-	X	X
Pecten murrayanus, Tate	-	-	-	-	-	X
Pecten polymorphoides, Zittel	-	-	-	-	X	-

Name of Specimens.	Upper Maude Beds.	Wauru Ponds.
<i>Pecten yahlensis</i> , T. Woods - - -	-	X
var. <i>semilævis</i> , McCoy	-	-
<i>Pecten subbifrons</i> , Tate - - -	-	X
<i>Pecten gambierensis</i> , T. Woods - - -	-	X
<i>Pecten</i> n.sp. aff., Eyrei - - -	-	X
<i>Lima Bassii</i> , T. Woods - - -	X	-
<i>Limatula jeffreysiana</i> , Tate - - -	X	-
<i>Limatula crebresquamata</i> , Tate M.S. - - -	-	X
<i>Spondylus pseudoradula</i> , McCoy - - -	X	X
<i>Lucina</i> n. sp. - - -	X	-
GASTROPODA.		
<i>Triton tortirostris</i> , Tate - - -	X	-
<i>Triton</i> n.sp. - - -	X	-
<i>Voluta</i> sp. (pullus) - - -	X	-
<i>Ancillaria pseudaustralis</i> , Tate - - -	X	-
<i>Drilla</i> 3. spp. - - -	X	-
<i>Conus heterospira</i> , Tate - - -	X	-
<i>Cypræa</i> spp. (casts) - - -	X	X
<i>Cypræa</i> sp. (cast of a very large species, probably <i>C. gigas</i>) - - -	X	X
<i>Natica Mooraboolensis</i> , Tate - - -	X†	-
<i>Thylacodes conohelix</i> , T. Woods - - -	X	X
<i>Thylacodes</i> n.sp. - - -	X	-
<i>Niso psila</i> , T. Woods - - -	X	-
<i>Cerithium Flemingtonensis</i> , McCoy - - -	X	-
<i>Cerithium</i> sp. - - -	X	-
<i>Triforis</i> , sp. - - -	X	-
<i>Liostia</i> sp. aff. <i>Roblini</i> - - -	X	-
<i>Tinostoma</i> n.sp. - - -	X	-
<i>Turbo</i> ? n.sp. - - -	X	-
Opercula of Trochoid shells - - -	X	-
<i>Pleurotomaria tertiaria</i> , McCoy - - -	X§	-
<i>Haliotis Mooraboolensis</i> , McCoy - - -	X§	-
<i>Haliotis ovinoides</i> , McCoy - - -	X§	-
<i>Scutus anatinus</i> , Donovan - - -	X†	-
PISCES.		
<i>Carcharodon megalodon</i> , Agassiz. - - -	-	X
<i>Carcharodon angustifrons</i> , Agassiz. - - -	-	X
<i>Lamna</i> sp. - - -	-	X
<i>Oxyrhina</i> sp. - - -	X	X
<i>Palate</i> aff. <i>Diodon</i> . - - -	-	X
MAMMALIA.		
<i>Ziphius (Dolichodon) Geelongensis</i> , McCoy - - -	-	X§
<i>Squalodon Wilkinsoni</i> , McCoy - - -	-	X§
<i>Cetotolites Leggei</i> , McCoy - - -	-	X§
<i>Cetotolites Nelsoni</i> , McCoy - - -	-	X§
<i>Cetotolites Pricei</i> , McCoy - - -	-	X§

NOTE.—Those marked § have been recorded by Sir F. McCoy, and † by Professor Ralph Tate, and those marked ‡ have been shown us by the Rev. A. W. Cresswell, M.A., who informs us he collected them from the locality indicated.

SUMMARY.

			Upper Maude Beds.	Wauru Ponds.
Zoantharia	-	-	2	4
Echinodermata	-	-	8	11
Crustacea	-	-	2	1
Palliobranchiata	-	-	9	10
Lamellibranchiata	-	-	8	11
Gastropoda	-	-	26	3
Pisces	-	-	1	5
Mammalia	-	-	—	5
Total	-	-	56	50

An inspection of the list of fossils from the Upper Maude Beds, and from Wauru Ponds, brings out the close relationship existing between them. The most noticeable difference is caused by the presence of gastropods in the former beds, but it should be noted, that nearly the whole of these were obtained from the section above mentioned, near the Clyde, on the east bank of the river, and from a deposit overlying the polyzoal rock. This overlying deposit really represents the clays occurring at the Filter Quarries, at Batesford*, where the majority of these gastropod species are well represented. The deposit is of a very peculiar nature, and at first sight looks like a sandy clay full of brown pisolitic ironstone pebbles. A closer inspection and the use of the acid bottle, show that it is really a calcareous clay, and that the supposed ironstone pebbles are nearly all recognisable as casts of fossils. Some of these preserve the external form, while others are merely internal casts. Gastropods, echinus spines and polyzoa are all found thus preserved, and the ornamentation of the mollusca is frequently well-shown. All the casts are highly glazed, and of a dark brown colour. They are easily separable

* See below, p. 193.

from the matrix, and are readily crushed between the fingers. It is then found that the ferruginous coat is very thin, and surrounds an earthy internal part of a light fawn colour, similar to the matrix in which the casts are embedded. We have not seen anything comparable to this method of fossilisation, and are at a loss for an explanation of the processes which have brought it about.

The older volcanic rock in the district is much decomposed, and towards its upper part is full of amygdules of carbonate of lime, while some lumps of radiating crystals of arragonite, about half-a-pound in weight, were found on the slopes. The soil produced from the decomposition of the basalt is very fertile, and the valley was formerly noted for its vineyards, which have, however, now entirely disappeared, having been uprooted when *phylloxera* was prevalent in the district some years ago.

Below the older basalt in the first section indicated, we find, as shown on the map, another outcrop of limestone, which is very variable in its composition. As a rule, it is arenaceous and earthy, and is in places full of casts while actual fossils are scarce. When they were obtained they were so encrusted with a strongly adhering calcareous coat that while we were gathering them we were rarely able to recognise them specifically, and were consequently quite in the dark as to the equivalence of the beds, especially as one of the commonest forms was a new species of *Trigonia*. There can however be no doubt, as an examination of the faunal list will show, that the limestone represents the lower portion of the Spring Creek section. As we approach the base of the limestone, fragments of slate and quartz make their appearance, and gradually become more abundant, till at length we find the limestone has disappeared, and a conglomerate of well-rounded pebbles has taken its place. In the limestone and conglomerate basalt pebbles are conspicuous by their absence, although we spent some time in a careful search for them. This fact, together with the considerable extent of the outcrop, its evident bedding, and the great change in fauna, precludes the idea of its being a talus. We did not, it is true, see the actual junction of limestone and overlying basalt; but, unhesitatingly, agree with the interpretation of Messrs. Selwyn, Wilkinson and Murray as regards their relationship.

This section then settles the age of the older volcanic rock. It is eocene. In a paper, read by ourselves, on 9th March of

last year* we stated that it would seem advisable to refer the older volcanic rock to two distinct periods, should it be found that it was anywhere intercalated with eocene rocks, as we showed that it was in some cases overlain by beds which had been referred to lower eocene. At a later date† we suggested that it might be found advisable to remove it altogether from the tertiary period. Messrs. Tate and Dennant, subsequently to our first paper,‡ stated that the older volcanic rock "may ultimately prove to be cretaceous;" while Professor Tate, in the tabular view of the Tertiary Strata of Australia, as given in his Presidential Address before the Adelaide Meeting of the Australasian Association, puts the older volcanic rock under the head of pre-eocene, while, by a strange oversight, the leaf beds underlying it are referred to the eocene period. There is, we now think, not sufficient evidence to suggest a subdivision of the volcanic rock, and certainly none for considering its age anything but eocene.

FOSSILS FROM LOWER BEDS AT MAUDE.

Zoantharia.

Placotrochus elongatus, Duncan.

Notocyathus australis, Duncan.

Bathyactis discus, T. Woods.

Echinodermata.

Maretia anomala, Duncan.

Monostychia sp.

Fibularia gregata, Tate.

Fibularia n.sp. (?)

Scutellina patella, Tate.

Annelida.

Serpula sp.

Polysoa.

Well represented.

Palliobranchiata.

Magasella compta, G. B. Sowerby.

Terebratulina Scoulari, Tate.

Rhynchonella squamosa, Hutton.

Crania sp.

* Proc. Roy. Soc. Vic., 1893, p. 1.

† Proc. Austr. Ass. Adv. Sci., Adelaide Meeting, p. 342.

‡ Proc. Roy. Soc. S. Aust., 1893, p. 212. Read 2nd May, 1893.

Lamellibranchiata.

- Ostrea sp.
- Dimya dissimilis, Tate.
- Pecten consobrinus, Tate, var.
- Pecten Foulcheri, T. Woods.
- Limopsis insolita, G. B. Sowerby.
- Limopsis Belcheri, Adams and Reeve.
- Pectunculus Cainozoicus, T. Woods.
- Cucullæa Corioensis, McCoy.
- Trigonia n.sp. aff. semiundulata.
- Cardita n.sp.
- Lucina leucomomorpha, Tate.
- Dosinia Johnstoni, Tate.
- Myadora tenuilirata, Tate.
- Corbula pyxidata, Tate.

Gastropoda.

- Turritella conspicabilis, Tate.
- Mathilda transenna, T. Woods.
- Rissoina sp.
- Tinostoma sp.
- Solariella sp.
- Cylichna exigua, T. Woods.

Scaphopoda.

- Entalis subfissura, Tate.

Pisces.

- Otoliths.

SUMMARY.

Zoantharia	...	...	...	3
Echinodermata	...	...	...	5
Annelida	...	...	...	1
Palliobranchiata	...	...	...	4
Lamellibranchiata	...	...	...	14
Gastropoda	...	...	...	6
Scaphopoda	...	...	...	1
Pisces	...	..	...	1

In the mollusca proper of the above list there are only three which have not hitherto been recorded from Spring Creek, namely, one lamellibranch which is a new trigonia, the diagnostic characters of which will be published shortly, and two gastropods. With regard to the representatives of the other classes, the majority also occur at Spring Creek, or in beds belonging to an equally low horizon in the tertiary series. This obviously shows the close relationship existing between the Lower Maude and Spring Creek beds. Upon stratigraphical grounds the Lower Maude beds are evidently very low down in the tertiary series. Our previous work in the Geelong district had led us to suspect that this was also the case at Spring Creek.

If we look at the results to be obtained from a critical examination of the Spring Creek fossils we have satisfactory confirmation of the above.

Messrs. Tate and Dennant, in their correlation paper,* record 227 species of mollusca, of these we are only able to pick out three living species which gives a *percentage of 1.3*. One of the above living species, namely, *Nucula Grayi*, *D'Orbigny* [= *Nucula tumida*, *T. Woods*] is, however, not recognised as such by Professor Tate. This identification has been made on a careful comparison of the living shells, dredged in Port Phillip Bay, with our fossil species. We have been able to add sixty-six molluscan species to the above referred to paper, making a total of 293, without increasing the number of living species, so that it seems perfectly safe for us to assert that the *percentage of living species in these beds is one*, or at most, very slightly over.

As the older basalt overlies beds of this horizon, and is overlaid unconformably by limestones of the Waurn Ponds type, and clays of the Lower Muddy Creek or Mornington type, the two latter conforming to one another with a gradual change in sediment where a junction is seen,† it will be of interest and importance to examine the results of the percentage theory as applied to the Muddy Creek beds. Messrs. Tate and Dennant, in the paper above referred to, state:—"Out of a total of 725 species of all classes from the two well-marked zones at Muddy Creek, 511 have been definitely traced to the lower beds. Of

* Trans. Roy. Soc. S.A., 1893.

† Proc. Roy. Soc. Vic., N.S., vol. iv., p. 11.

these, from six to eight still survive, and the percentage of recent to extinct forms is thus about one and a half." In the list of fossils appended to Messrs. Tate and Dennant's paper, there are only 250 mollusca from Muddy Creek, which is obviously incomplete. Mr. Dennant, in a much earlier paper,* refers 405 species of mollusca to the lower zone. There are at least *ten recent species* now known from these beds which gives a *percentage of nearly two and a half*. It is not quite clear whether the 511 species mentioned above is intended to indicate mollusca only, but even if this should be the case, as is likely, we would still have nearly two per cent. of living species, which decidedly indicates an horizon younger than the Spring Creek beds, and is confirmatory of the stratigraphical sequence already indicated.

The section at North Belmont shows a resemblance to the Spring Creek beds in the occurrence of:—*Cucullaea Corioensis*, *McCoy*, *Trigonia semiundulata*, *McCoy*, *Chione Pritchardi*, *Tate m.s.*, and *Chione cainozoica*, *T. Woods*, and some common forms of echinoderms and palliobranchs, and may tentatively at least be placed on the same horizon until more evidence is forthcoming.

According to Sir Alfred Selwyn,† the beds containing plant remains pass under the marine tertiaries to the north of Maude, but our stay was too short to allow us any time for examining the evidence on this point. In the sections on Sutherland's Creek, to the eastward of the first sections we mentioned, we find the ordovician rocks overlain by nearly 100 feet of quartzite and sandstones. The grain of this rock is fairly fine, and we found no trace of gravel or conglomerate in the beds. The change from loose sand into fairly compact sandstone, and then into quartzite seems very irregular. At the point where the ordovician is lost sight of as we go south, the overlying series consists of a white or brown rock on which the hammer makes but little impression, so that the alteration has been effectually carried out. In some places higher up the stream the quartzite may be traced up to the top of the deposit, whilst in others, the upper part consists of loose sand. It is not quite clear whether the beds are the equivalents of the lower limestone of the Moorabool Valley above described, or of the plant beds, though the latter seems more probable.

* Trans. Roy. Soc. S.A., 1888, p. 39, *et seq.*

† Exhibition Essays, 1866-67, pp. 21, *et seq.*

With regard to the occurrence of a quartzite in the tertiary series, Professor J. W. Dawson, in speaking of one overlying the eocene in Egypt, uses words which exactly apply to our rock.* "The Red Mountain, near Cairo, . . . is composed of a hard brown, reddish and white sandstone . . . In many parts it has the characters of a perfect quartzite, and appears at first sight extremely unlike a member of the tertiary series . . . The induration of the beds seems to be local, and to be connected with certain fumarole-like openings, which have probably been outlets of geysers or hot siliceous springs contemporaneous with the deposition of the sand." Perhaps the same cause has been efficient at Maude. A somewhat similar tertiary quartzite, it may be mentioned, occurs at Keilor, but is higher in the series, and is capped by newer and not by older basalt.

Overlying the quartzites of Sutherland's Creek, we have the older volcanic rock, and over this again limestone of a similar nature to that already described in the previous section. On the eastern side of the valley this is in some places capped by the newer volcanic rock. Near the most southerly outcrop of the ordovician on Sutherland's Creek we found the section to be, approximately, as follows :—

Newer volcanic	...	...	40 feet.
Sandy limestone	...	...	20 "
Older volcanic	...	...	60 "
Quartzite and sandstone	...	...	90 "
Ordovician slate	...	...	40 "
			<hr/>
			250

THE SEQUENCE OF SOME OF THE VICTORIAN EOCENE BEDS.

The recognition of the fact that the sandy limestone underlying the older basalt of Maude, is practically the equivalent of the lower part of the Spring Creek section, and that the upper beds at Maude are the representatives of those at Waurn Ponds, supplies a hint that is of use in unravelling a good deal of the stratigraphical sequence of the eocenes, and we have gathered together a few facts which show that we are now in a position to

* Geol. Mag., N.S., Dec. III., vol. i., 1884, p. 385.

do something towards a better understanding of the deposits. That there are different horizons is what we should expect to find, and though lithological and bathymetrical conditions will constantly have to be kept in view as affording some explanation of differences in the faunas of different localities, still to ascribe everything to this and to "colonies," is surely asking more than is likely to be granted. An examination of the published lists of fossils from the lower beds of Muddy Creek,* Mornington, Gellibrand, and Camperdown,† Lower Moorabool Valley (Fyansford, etc.),‡ Belmont and Curlewis,§ Bairnsdale,|| will show that these beds are on much the same horizon, though the exact relationships are not yet definitely fixed. No lists have been published for Corio Bay, Altona Bay, Newport, or Murgheboluc, but our knowledge of the desoposits enables us to refer them to the same series, as the number of fossils at present known to us from these localities is as follows:—

Corio Bay	...	...	150 species.
Altona Bay	...	...	70 ,,
Newport	...	...	115 ,,
Murgheboluc	...	...	102 ,,

From Shelford we have over one hundred and fifty species, gathered by Messrs. Donald Clark, Betheras, and Alex. Purnell, which show that this deposit also may be referred to the same group.

We have shown that the clays at Curlewis¶ overlie a polyzoal limestone similar, lithologically, to that of Maude, and the same is the case at Batesford.Ⓜ With regard to the latter place, it may be mentioned as a further confirmation of our previous reading of the section, that the work carried on at the "Filter Quarries" has displayed a face showing the limestone capped by about ten feet of eocene clay, rich in fossils, together with a thin clay band

* Trans. Roy. Soc. S. Aust., 1888, pp. 40-52.

† *Id.*, 1893, pp. 218-26.

‡ Proc. Roy. Soc. Vic., 1891, pp. 18-26.

§ *Id.*, 1893, pp. 10-13.

|| Proc. Roy. Soc. Vic., 1890, p. 67. For most of these localities see also "Remarks on the Tertiaries of Australia; together with Catalogue of Fossils"—South Australian School of Mines and Industries, Adelaide, 1892.

¶ Proc. Roy. Soc. Vic., 1893, p. 3.

Ⓜ *Id.*, 1891, p. 11.

intercalated with the upper part of the limestone. This clay is remarkable, chiefly for the great preponderance of trochiform shells, but otherwise resembles the section described by us on the other side of the valley.

There is little doubt that the polyzoal limestones of Waurn Ponds, Maude, Curlewis, and Batesford, are on the same horizon, though slight differences in the faunas certainly exist.

At Flinders and at Airey's Inlet,* at Curlewis and at Maude, a polyzoal rock rests on the older basalt. This in its turn, at Maude, overlies a sandy limestone containing a fauna which is the equivalent of that of Spring Creek. At Waurn Ponds the limestone overlies a clay in which fossils have not as yet been found, but which Mr. Wm. Nelson states† to closely resemble that of Spring Creek.

The Waurn Ponds rock can be traced almost uninterruptedly from M'Cann's quarries, which is the best known exposure, as far as a quarry on the south side of the Barwon River opposite the end of Pakington Street, Geelong. The locality of this quarry we shall indicate by the name of North Belmont. The rock here is a sandy limestone, and the fauna shows a stronger relationship to that of Spring Creek on account of the greater number of mollusca which it contains; though, unfortunately, most occur merely as casts. The dip of the beds is well pronounced being E. 40° S. at 10° . This would carry them below the Belmont clays shown in the oft quoted well,‡ and Mr. J. Mulder informs us that limestone was struck at the bottom of the shaft after passing through the clay beds.

The polyzoal rock then appears to be antecedent to the clays of the Lower Muddy Creek type, and to overlie beds with a fauna similar to that of Spring Creek.

It will be seen that we almost entirely reverse the sequence as interpreted by Professor Sir Fredk. McCoy, and adopted by the Geological Survey. According to this view the clays of Mornington, Southern Moorabool Valley (Fyansford, etc.), and

* Proc. Roy. Soc. Vic., 1893, p. 18; Trans. Roy. Soc. S.A., 1893, p. 212; Krause, First Prog. Rep. Geol. Surv. Vic., 1874, Section IV.

† Proc. Geol. Soc. Aust., vol. i., pt. i., p. 19, 1886.

‡ Proc. Roy. Soc. Vic., 1893, p. 16; and Prof. Tate, Trans. Roy. Soc. S. Aust., 1893, pp. 216, etc.

the Gellibrand River, are the the lowest members of the tertiary group occurring in Victoria, and are referable to the oligocene period, while the beds at Spring Creek are divided into upper, middle, and lower miocene. Selwyn states* that the older volcanic rock marks the close of the miocene period. These views are adopted by Mr. R. A. F. Murray in his work on the Geology of Victoria.

Professor Ralph Tate and Mr. J. Dennant in their paper on the Correlation of the Marine Tertiaries of Australia,† do not attempt any subdivision of the eocene beds, but state that by Professor McCoy the deposit at Mornington “is correctly placed at the base of the tertiary series,”‡ though, whether they intended to imply that it is the oldest of our eocene beds is not clear. Of the older basalt it is said that it may “ultimately prove to be cretaceous,”§ while more recently Professor Tate, as above indicated, refers it to pre-eocene age. Below this series of rocks we have, as shown by Selwyn,|| at any rate one set of leaf-beds, namely those occurring below the older basalt. Whether these beds are still to be retained in the tertiary period, or are to be referred to cretaceous times is, as we have previously shown, still an open question.¶

SUMMARY.

Judging by the percentage of recent species of mollusca occurring in the various deposits, we should expect those of the Spring Creek type to underlie the clays of the Lower Muddy Creek type, and the detailed stratigraphical evidence that we have brought forward points in the same direction. We are then, on these grounds, justified in arranging the eocene rocks of Victoria, in so far as they have been critically examined, in the following order, beginning with the highest beds.

1. CLAYS OF THE LOWER MUDDY CREEK TYPE.—Occurring at Muddy Creek, Mornington, Belmont, Curlewis, Lake

* Exhibition Essays, 1866-67, p. 29.

† Trans. Roy. Soc. South Australia, 1893.

‡ *Loc. cit.*, p. 216.

§ *Loc. cit.*, p. 212.

|| Exhibition Essays, p. 21.

¶ Aust. Ass. Adv. Science, Adelaide, 1893, p. 338.

Connewarre (Campbell's Point, etc.), Southern Moorabool Valley (Fyansford, etc.), Corio Bay, Altona Bay (bore), Newport (shaft), Gellibrand, Camperdown (Gnotuk), Murgheboluc, Shelford, Bairnsdale (Mitchell River).

2. POLYZOAL LIMESTONE OF THE WAURN PONDS TYPE.—Occurring at Waurn Ponds, Batesford, Maude, Curlewis, Flinders, ? Airey's Inlet, ? Muddy Creek.
 3. OLDER VOLCANIC ROCK.
 4. CLAYS AND LIMESTONES OF SPRING CREEK.—Maude and (?) North Belmont.
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